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ABSTRACT

This research proposes a conceptual structure for an Environmental Information System. An Eco-Systems approach is employed maintaining whole units of analysis allowing for collection and storage of information of use to regional environmental planning and design. The suggested system design incorporates some of the basic concepts of the two sub-components of the environment--natural and manmade. The system is admittedly only partially inclusive allowing for incremental incorporation of related concepts, research findings, and existing information systems. (Author/RE)

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# The Conceptualization of a Regional-Ecological Information System Essential to Environmental Design and Community Development in the State of Nebraska

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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## Abstract

This research proposes a conceptual structure for an Environmental Information System. An Eco-Systems approach is employed maintaining molar units of analysis allowing for the collection and storage of information of utility to regional environmental planning and design. The suggested system design incorporates some of the basic concepts of two sub-components of the environment--the natural as well as the man-made. Such a system is admittedly only partially inclusive allowing for the incremental incorporation of related concepts, research findings, and existing information systems.

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Lincoln, Nebraska
April 13, 1976

W.C.S.
J.A.M.

## PREFACE

"The right kind of information applied by knowledgeable participants at strategic junctures in the stream of community life can make a difference in the direction and quality of living."

Howard Y. McClusky

Environmental information is not available in a centralized, comprehensive format to the decision-makers for community development within the State of Nebraska. The current concern and assistance to community improvement centers around the environmental elements of air, water, energy, and solid waste. However, there is a need to consider as well the nature of the relationships and interrelationships among population; pollution; natural resource allocations; transportation; technology; cultural, social, political and legal components of the environment; and their significance to environmental design and community development. One means of accomplishing this is to employ an eco-systems approach.

The original purpose of this research project, as initially proposed, was two-fold. First, to develop a state-wide environmental quality inventory of communities; and second, to establish an environmental data and resources inventory as an aid to community development. The accomplishment of these two tasks would be of assistance in developing alternative environmental designs for community development within the context of eco-system theory.

In progressing to achieve these initial objectives, it became obvious that the basic commodity being pursued was relevant information on the environment. It became necessary to determine the existing level of information available within the State. This entailed making contacts with the appropriate local, state, and federal governmental agencies. As a result of the amount of material and data that was generated, some means had to be developed to store this information. Efforts were made to discover an appropriate methodology for the examination and analysis of pertinent information. In doing these procedures, it was discovered that at the state and regional level, there was no comprehensive and consistent format for collecting, storing, and analyzing information of utility in community development.

In response to this deficiency, and in conjunction with the stated purpose of this research, it was conceived that an important prerequisite to the collection of data on environmental quality was the need for an appropriate environmental information system. The major result of this decision was the development of a tentative conceptual framework for such a system. It is suggested that within this framework it is possible to store, analyze and retrieve pertinent information relevant to environmental design. Furthermore, such a system can serve as a foundation for the investigation of the nature of the interrelationships among the various elements present within the context of the eco-systems approach.

Related to the general objective of this research was the production of two further significant papers. First, the issues surrounding the use of visual documentation and simulation were investigated as they relate to environmental design. Second, the voluminous amount of literature

on the related topics suggested the need for a comprehensive bibliography of special utility for those interested in doing future research.

One of the inherent goals of research is to suggest possible alternative courses for future work. The nature of this report is basically in an advisory capacity, relative to the concerned State agencies. We do hope that some of the recommendations offered within this paper are of utility to the planning process and environmental design considerations in Nebraska. Furthermore, the tentative environmental information system in conjunction with the suggestion for further research within the area of Indoor-Outdoor Recreation as it relates to environmental quality may prove a beneficial means of testing the applicability of the eco-system approach as proposed within this research.

# I. INTRODUCTION

Planning, as a local government function, will require even larger quantities of information about the man-made and natural environments it is seeking to modify.

Fragmentation and variations in documentation and data about the processes occurring within these environments are serious problems. Tô cope with this, some method of synthesis and analysis is required which integrates the information at both the micro and the macro unit of analysis. What is proposed is an integrated ecological information and decisional system which conceptually views the urban and rural environments as being composed of major subsystems which are interrelated in terms of informational flows.

The body of this report conceives the operation of a state-wide information system as a component of the decision-making process for directing change in the society. The methodology suggested in the construction of such a system aims not only at the systematization of information enabling decision-making but also at the simulation of alternative courses of action, approximating resultants, and evaluating courses of action actually implemented. The possible information system then serves four related purposes:

1. An enumeration of data, or statistical summary of same, collected accurately and reliably across a set of stable variable measures at specific time intervals

2. Such information may be used to form policies regarding planned change and/or specify the conditions and locations in which policies and subsequent programs may be implemented

3. In that policies may suggest a set of alternative programs of action, the information system may be manipulated to form a simulation model of an area in order to "test" the proposed

courses of action measuring the anticipated effects and determining consistency within policy objectives

4. The simulation model, together with pre-program data and post-program data may be used to evaluate the performance of a program with respect to original policies, or comparatively, across or among several program types

The objectives of the present research effort were to define the scope and content of the system such that the first purpose could be achieved. The systematic collection and storage of data, while significant in itself as public record, has no significance unless it is convertible into assistance in decision-making. The utility of the system and any of the models derived upon it is dependent upon its ability to assist in decision-making regarding social and physical environmental change. The sets of data to be collected are not to be encyclopedic; they are selectively specified, as each measure is seen to be necessary in one or more areas of decision-making; and the measures, when taken together, provide sufficient information to enable a decision. On the one hand, the data sets must be responsive to the significant and recurrent decision-making areas of various planning agencies. On the other hand, in that social and physical environmental change may generate wholly new areas of debate requiring public decision-making, the information system must have a degree of comprehensiveness in both "cross-sectional" and "longitudinal" measures. Where some variables are latent, the system must be sufficiently comprehensive to contain "intervening" or "proxy" variable sets. Assuming the ability to construct such a system, both analytical models and predictive models could be constructed which would test program alternatives for consequences, thereby operating as a mechanism for policy development and implementation. Various criteria could be introduced into the operations of the models (as affixing cost-

benefit priorities, minimal capital improvements requirements, relative need, equality of accessibility, uniform cash flow of expenditure, etc.). Assuming that policies are selected and programs are developed for implementation, the anticipated consequences of these programs could be placed within the model for comparability with desired policy results. Finally, program performance could be measured against both pre-program data and the simulated predictions. Such program justification may be extended on a comparative basis, where "similar programs" under diverse conditions and circumstances record differential results. In these last three possible functions for the information system, particularly in the area of post-program evaluation, the goal structures from which policies and program are sequentially derived must be coherently and precisely formulated. If the logic of goals formulation is incoherent and/or inconsistent, then the derivation of policies and programs will have no utility in decision-making.

The sections which follow are systematically arranged. Chapter Two discusses some of the major concepts and assumptions concerning regional planning, the eco-systems approach and community development. Also, some of the problems associated with comparing varying levels of data are briefly examined. Chapter Three reviews the important elements of information retrieval systems and their design. Chapter Four offers a possible conceptualization of the proposed information system for the State of Nebraska. Chapter Five recommends a test of the system, calling for the operationalization of one segment of the system--Indoor-Outdoor Recreation. Finally, some conclusions and recommendations are offered with regard to the complete operationalization of the system.

## II. THE REGIONAL PLANNING PROCESS AND THE ECO-SYSTEM APPROACH

### A. Systematic Regional Planning Process

If planning is conceived of as a systematic thought process whereby certain decisions are made to change society and the environmental condition, then some methodology must be available which allows for the operationalization of a number of concepts and testing of alternative courses of action, as well as consequences.

The approach taken in this study is based on the idea that there are a number of varying elements or subsystems within the real world which are interrelated. These elements can be separated and the relationships or interactions between them can be analyzed. Within this context, planning is viewed as a continuous cyclical process in which humans devise means of affecting the elements of the system and of evaluating these affects as they are placed on the system.

What tends to be most significant about this approach is the concern the planner demonstrates for describing and explaining what is occurring in the world. Such information is then employed to develop alternative solutions to problems. The consequences of these solutions can then be evaluated or tested by means of simulation or modeling techniques. The approach then offers the client or decision-maker a relatively small list of improved solutions from which to choose the one that it is felt to be most appropriate. Also, a narrow number of important measures of system costs and benefits can be presented.

At the same time, the explicit nature of this systematic methodology provides a decision-making framework, which tends to increase the likelihood that the proper questions and considerations will be taken into account. That is, this process leads to a consideration of many determinants which otherwise might be overlooked; such as, new or different

environmental decision criteria, as well as new or different alternative environmental systems.

Another advantage of the system's approach is not in indicating the preferred system of systems among a predetermined set of alternative systems; rather, it is in the suggestion of new additional systems. These may have been previously ignored or not considered or they may be newly generated systems invented to rectify deficiencies in other systems.

B. An Eco-System Approach

An eco-system may be thought of as a complex and organized system consisting of physical, chemical, biological, and human elements, as well as the set of interactions and processes between the elements within the system, the subsystems, and the environment or each subcomponent of the entire eco-system.

The urban eco-system may be conceptualized in the same fashion with the exception that it is composed of interacting economic, social, political subsystems. Stearns and Montag (1974) list the chief components of the urban eco-system as follows:

-populations (human and non-human)

-physical structure (natural and human constructed)

-resource flows (materials and energy as the result of natural and human initiated processes)

Because of their interrelationships, the human and natural systems cannot always be clearly separated and identified. That is, the physical, biological, and cultural links between the human components of the urban system and the natural system are difficult to differentiate. In the urban eco-system, economic, political, and social processes are considered to be the dominant influences determining the system's structure and behavior in the short term. However, the nature of the natural ecological system may represent constraints on human activities in the long run, as does the resiliance of the natural

system to the manipulations by human activity. These must be included in any comprehensive examination of the nature of the urban environment.

Characteristic of all eco-systems, including the urban eco-system, is a self-regulating system of positive and negative feedbacks. The tendency of these feedbacks is to maintain a state of dynamic equilibrium. Human intervention has tended to produce instability or tax the self-regulating process. Within the urban eco-system, particularly with respect to predominantly human-generated systems, the tendency has been to reduce negative feedbacks allowing positive feedbacks to operate unrestrained. For instance, population increases, at an increasing rate in many instances, tend to be the result of the limiting of the negative feedback effects of food shortages, diseases, death rates, etc. Ultimately, the destabilization of the global eco-system as a direct result of human activity can threaten the stability and hence survival of the human social system.

The eco-system approach is an attempt to examine the social and physical environments in systematic/operational terms. It realistically demonstrates its complexity, its integration and interdependencies, recognizing the interwoven roles of all elements in the urban system and places emphasis on these interrelationships. That is, it is one means of discovering the interrelationships that are present within the social and physical environments.

It is felt that if the urban eco-system is to be able to continue to regenerate and evolve, then an increased awareness and understanding of the implications of ecological systems are essential. A related suggestion is the development of an ecological information system which contains measures of the relationships between environmental quality and social systems.

C. System Functions and Levels of Government

The utility of the information system or any of its processes may be significantly affected by the level of government employing it. While the information contained in the data files, as a matter of public record, would be accessible to all public and private decision-making bodies, the prime objective of the system seems bent toward the formulation of public policy and implementation of programs either directly or indirectly by public agencies. The utility of the information system is dependent upon the function which the unit of government performs. While all four functions of the information system may be required by the state government, utility of the system may be significantly changed in the shift to regional (sub-state) levels and corresponding regional agencies. Regional agencies are of two general natures: (a) an agent of the state (a subordinate unit of state administration) which may hold advisory and/or regulatory powers, and (b) a self-governing unit (a unit of government which holds specific authorization and powers by virtue of constitutional provision, statutory delegation or charter provision). In a general sense the information in the system may be supplied through the regional agency for its own uses or as advisory material for local community decisions. But some regional agencies may be required to expedite state policies and programs and monitor and evaluate programs implemented at both the regional and local levels. (It may be that their regional agencies are charged with the compulsory collection of the data for the continued operation of the system). Here the system must be sufficiently comprehensive to accurately assess the "unique conditions" of a region and of its subordinate units. While the regional agency may be charged with implementing state policy as uniformly as possible, these unique conditions may require significant alteration in program

content and methods of implementation. These "unique conditions" must be considered again in program evaluation of performance variations.

When the agency employing the information system is a self-governing unit, the system must be capable of providing information which is both sufficient and necessary at that level of governmental unit. Since regions may differ significantly in their characteristics, giving rise to diverse decision-making activities, the information system must be capable of providing not only the "common measures" occuring among regions but also the "peculiar measures" of significance perhaps only to a small part of one region. (In fact, the setting up of the state-wide information system and the collection and analysis of initial data may be productive in giving or refining regional boundaries for various functions.) Shifting to local units of government (sub-regional jurisdictions), the utility of the system in general may be more limited by the increased significance of "unique conditions." While certain variables may be particularly crucial to local self-government, their incidence within or among regions may have been too low to warrant incorporation as a variable scale in the state-wide data bank. The local governmental units must then rely on data which is neither in the data system at the time of decision nor in the data bank at the time of program evaluation. While the systems model of simulation and evaluation may be useful for localities, the "unique conditions" problem is likely to influence both the "calibrations of model operations" and the "selection of criteria" used in program performance evaluation.

D. Some Problems of Comparative Analysis

Aside from the use of the system in evaluating programs with respect to conformance with policy, program performance may be comparatively measured across areas or regions. Again, while state-level policies may be uniform across all regions, programs developed for specific regions may vary

in content and method of implementation. One difficulty of such comparative analyses is the adequacy or inadequacy in which "similar" regions or areas are identified. To designate that two or more regions or areas are "similar in all relevant aspects" presumes that the original data bank is both sufficiently comprehensive and sufficiently precise such that all "similar aspects" have been identified. Moreover, there is the presumption that there are no "latent" variables missing from the data bank which are in fact critical "unique conditions." At the local levels of government, there may be at a superficial level a significant number of "like" areas; but because decision-making occurs within a particular context, decision-making may become increasingly dependent upon those unique conditions missing from the data bank of the system. This problem of making comparisons is more than technical however. Making comparisons among "similar" areas and the subsequent articulation of policy and program by "type" of region or area may generate an "homogenization" of planning activities and decisions among and within regions. While it is the obligation of the State to assure uniformity in the application of public policy, the objective of both regional planning and community development transcend these purposes, responding not only to public policy considerations but also to the particular opportunities and resources of regions and local communities which are "unique conditions."

E. Community Development and Information Systems

While the information system may function beneficially for the purposes of regional planning within a state, the purposes of community development are far wider than those usually associated with regional planning. The regional planning activity, as it may have impact on the local communities, must presume a social, economic and political order to realize its objectives.

Community development has as part of its purposes the alteration of and improvement of various aspects of social organization, economic activity, and political participation. While the goal-formulation, condition-assessment, decision-making and implementation activities of community development may intersect with those same activities in regional planning, the activities may not be compatible in purposes. The community development process is more likely to focus attention on assisting persons in developing decision-making capabilities as individuals and assisting those individuals into participation in community decision-making processes. The emphasis of community development is likely to be geographically small or "local" but sociologically "comprehensive." The community development process is more likely to concentrate its activities in local self-assessment, local self-determination, and to significant degree, local self-implementation. The regional planning process is more likely to be geographically "expansive" but sociologically "narrow," concentrating upon ecological variables. Regional planning is more likely to focus upon the implementation of state-wide policies or regional policies as administrative actions rather than focus upon the advisory role of providing information to local units of government in enabling local decision-making.

Given these two orientations, the utility of the information system as a tool in regional planning may be severely limited when applied to local community development processes. While the information contained in the system may assist in the formulation of state-wide and regional policies, the application of such policies and specific programs in localities may generate conflict in the assessment of local conditions. The peculiar interests and capabilities of the community and their "unique" environmental context may generate very unusual but nevertheless fully appropriate local self-determinations. The use of the state-wide information system in

generating policy and programs could have the effect of "homogenizing" the community development activities in localities. In that the data system could be used for comparative evaluations of program among local communities, the comparisons could subtly subvert the objective of the community development process by stressing "common measures of performance" rather than upon the particular assets of the local environment and capabilities of community groups. There are three problems in the use of the information system in the community development process: (a) that the content and scope of information in the system is inappropriate and/or insufficient to enable local decision-making; (b) that the information system fails to account for (in an accurate and reliable manner) those "unique conditions" which may have very local, but nevertheless crucial, importance; and (c) that the evaluative models developed from the information system may be subversive to local development initiatives.

The utility of the information system in community development can be increased if its construction and use by state and regional agencies is altered in three aspects: (a) expansion of the scope of data to account not only for variables "common" to several regions, but also for variables which are "unique" to a single region or to one of its components; (b) that policies and programs developed by use of the system are sufficiently flexible to permit adaptation to those "unique" conditions; and (c) that the use of the model as an evaluation device serves two separate functions--standard cost accounting and program recommendation. One of the significant functions of the information system is the analysis of productivities of various programs, but this function must not be employed directly or specifically as a recommendation device for future decision-making. The evaluation of programs in regions and in communities can be completed under a variety of

criteria, recommendation of program content and method of implementation can be made on the same variety of criteria. But in terms of community development, the choice of criteria is the province of the community itself. Knowing the relative success or failure of other community programs may be of significant use to localities considering new programs. The use of evaluative analysis from the information system can be used to inform and advise regional and local bodies in policy and program decisions. If, however, the evaluative analyses are used to manipulate local programs without concern for particular circumstances, the local self-determination of communities thereby being subverted, the information system can be seen only as dysfunctional to community development processes.

## III. SYSTEMS DESIGN AND INFORMATION RETRIEVAL SYSTEMS

### A. Systems Design

Design usually means the development of a system configuration or structure. Without going into great detail about the methodology, Van Gigch (1974, p. 11) summarizes the major characteristics of the design process as follows:

1. The problem is defined in relation to superordinate systems, or systems to which the system in question belongs and to which it is related by a community of objectives.
2. The objectives of the system do not usually lie in the context of subsystems but must be viewed in relation to larger systems or the Whole System.
3. Present designs must be evaluated in terms of opportunity costs or the extent of divergences of the system from the optimum design.
4. The optimum design cannot usually be found incrementally nearby present adopted forms. It involves the planning, evaluation, and implementation of new alternatives which offer innovative and creative departures for the Whole System.
5. Systems Design involves processes of thinking such as induction and synthesis which differ from deductive and reductive methods.
6. Planning is conceived as a process where the planner assumes the role of leader instead of follower. The planner must encourage the choice of alternatives that alleviate and even counter, instead of reinforce, the unwanted effects and tendencies of previous systems designs.

If systems design deals with questioning the nature of a system, then implicit in this process is the making of decisions with respect to certain issues. There appear to be three distinct phases of decision-making which Van Gigch (1974, p. 71) thinks are important:

Phase 1. Policy making or preplanning is the phase during which the problem to be solved and the needs and the objectives to be met are defined. Agreement must be reached on the premises, assumptions, values, and priorities which will guide decisions during subsequent stages of design. The preplanning phase includes the search for and generation of alternatives, as well as a determination of their corresponding outcomes and consequences.

Phase 2. Evaluation results in the determination of attributes and criteria according to which the various alternatives can be evaluated on the extent to which they satisfy objectives.

Phase 3. Action implementation is the phase when the chosen design is put into effect. Results of the action are appraised in terms of needs satisfaction.

This characterization of the systems design process in relation to the decision-making process is demonstrated in Figure 1.

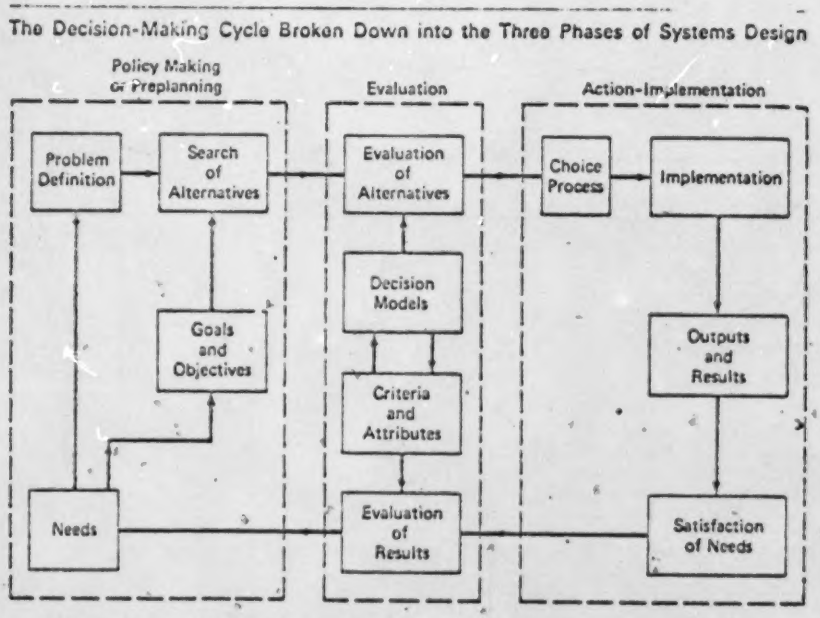



Figure 1

Source: J.P. Van Gigch. Applied General Systems Theory (New York: Harper and Row) 1974, p. 72.

B. Information Retrieval Systems

There are two basic elements to the development of an operational design for systems analysis: the data base and the data processing system. A suitable data base is a prerequisite to the generation of the data processing system. This is constructed of a number of data "files" which pertain to the collection and organization of data units into a communicable language. This implies the existence of a structure for organizing the data.

The system as proposed in this study should contain a document retrieval component and a data retrieval subsystem. In the case of the former system, documentary information should be entered with appropriate citations (i.e., laws on environmental pollution may be the entire document whereas sections on federal funding requirements could be cited). In the latter subsystems, data retrieval depends upon statistical information which has been previously stored. For example, the amount of money generated from increased sales tax, the number of minority residents in North Omaha, the quantity of low-income housing in different areas of the state, and so on.

Before continuing, it may be beneficial if a digression is made to discuss the process involved in information retrieval systems. Such a discussion may clarify some issues involved with regard to the overall objectives of the research project.

Let us assume that a certain state agency or private citizen is interested in discovering some information on the effects of increased irrigation in the Mid-State. If the information is within the computerized system, a search question is entered in words or other symbols by the inquirer or the programming staff. The system selects those documents and that data which match in terms of the words or symbols common to both the search question and associated with document and data as it is stored.

In many instances, time is of the essence. To increase the rate of retrieval, documents are indexed upon entry to the system. That is, the key words for each document are selected so as to be descriptive of the information content. These descriptions are filed, together with the address of the document in the data bank; and it is this file which is scanned by a selector. Since the number of words in the file is less than the number in the data bank, the scanning time is greatly reduced.

As the storage collection increases, it becomes difficult to scan the file in a reasonable time. Instead of scanning the descriptor file sequentially from end to end, the descriptors are ordered allowing for the occurrence of a multi-level search (i.e., an example would be an alphabetical index).

The method of retrieval may be outlined as follows:

A. Storage

1. A document is scanned by an indexing mechanism, which assigns to it:
   a. A specification (a bibliographical description of the document, constructed in accordance with cataloging rules
   b. Selected descriptors (a subject analysis of the document, constructed in a controlled Descriptor Language
   c. A Data Bank address

2. The document is labeled by its address and is placed in the Data Bank mechanism

3. The address, specification and descriptors are appropriately placed in a File by a Filing Mechanism

B. Retrieval

1. An Inquirer presents a search question

2. The question is transformed into a set of descriptors by a Query Formalizer, using the Descriptor Language

3. The search descriptors are matched with file descriptors by a File Selector which delivers matching addresses and specifications

4. The Inquirer selects certain specifications as most relevant to his question

5. The selected addresses are located in the Data Bank by a Document Locator which delivers the corresponding documents

The last decade has seen a recognition on the part of several states for the development of environmental and land use classification and information systems. Developed independently, a wide variety of systems have emerged, ranging from consolidation of previously fragmented agencies to computerized classification and cataloging systems. It is useful to consider the

experiences of a number of these "experiments" in formulating a viable answer to Nebraska's needs in the area of future-oriented land management and environmental planning.

In many of the state information systems reviewed in this paper, the emphasis has been on improving the capability of state and local government planning agencies to deal with environmental and ecological information. What follows is a survey of current operational systems, the processes by which they were developed, and some of the major problems that have directly evolved from the creation of these information systems. Such a survey can be very beneficial in that it can minimize the occurrence of these issues within the proposed system for Nebraska.

C. A Review of Selected Information Systems

NEW YORK: The Land Use and Natural Resources System--LUNAR

The natural resources and land use inventory used by New York State is an operational information system being utilized by various departments of the State, private individuals, corporations, and researchers at the various colleges and universities throughout the State. Two events, arising independently, coincided in New York at the beginning of the project. First, a group of computer and statistical researchers working at Cornell and Harvard had developed a computer graphics program--SYMAP--which utilized data and distributed it geographically. It took point data and expanded it to a grid scale. Experimental studies were done in a selected area on the East Coast. Second, Governor Rockefeller, at the same time as SYMAP was being developed, pledged to have a state-wide land use inventory completed in three years. Thus, through a fortunate coincidence, the funding was solved simultaneously with the basic research and development for the appropriate system.

The first step was base-map compilation. This consisted of 1,000 quadrangles covering the 50,000 square miles of the State. The photographic data was acquired by aerial blanketing of the State within a 2 1/2 month

period around the fall of 1967. Using 7 1/2 minute quadrangles as the base-mapping unit, the photographs were scaled at one inch equals 2,000 feet. Thus, the scale change is minimized when transferring the photographic data to the base maps. This was an essential step prior to placement on tapes and discs and into the computer for retrieval.

The next step was to develop a classification code, and in parallel, a grid system for the State. The original code devised by the Commissioner of Conservation listed six items for classification: water, woods, farming, urban, and a commercial-industrial breakdown. After inviting the opinions of potential users of the system the list grew to 136 items. As for the grid, two sizes were determined to be needed--smaller cells for the more densely developed urban areas and larger cells for the rural areas requiring less definition.

The photographic data which had been collected had to be interpreted before transfer and this was found to be work sufficient for about fifty people who had to be specially trained. The photographic input comprised 85 percent of the total information input in the system. The other 15 percent was composed of secondary information; such as natural boundaries, plant and soil characteristics, building identification, and so on. These were presented as transparent overlays over the topographic map. Sometimes several overlays were used. The first showed land use and the boundaries of the study area. The second overlay was needed often because the first had become too cluttered. The third overlay depicted minor civil divisions; such as township lines, county lines, and villages, as well as road classifications.

The material from the overlays was put together and recorded for each cell. It was then entered onto a form sheet, placed on an IBM punch card for each cell, read onto a tape, and finally onto a 2316 disc pack that

stores the entire system on the equivalent of slightly more than one 12" record. When it became apparent that SYMAP was not designed for such large amounts of data, two programs evolved to cope with the data. One is PLANMAP which derives a graphic display and provides maps for any kind of area. The other is DATALIST which produces summaries of data. In this manner, the original data is reproduced both by means of graphic display and tabular statistics.

The cost of this particular project came to about $10 per square mile. The inclusion of censustract data was expected, when implemented, to increase usership approximately 100 percent. The updating of the land use inventory will take place every two years in urban areas, every five years in active agricultural areas and every ten years in the rural forest abandoned areas.

The New York Center for Aerial Photographic Studies was responsbile for the bulk of the data gathering and photographic work which, as mentioned, comprised 85 percent of the total input. The program was monitored by the Office of Planning Coordination and other State agencies; such as, the Conservation Department contributed much in secondary data for the overlays. The State of New York put in only $147,000 (30 percent) of the half-million dollar expense of the project; the rest being provided by HUD's "Appalachia" funds.

MINNESOTA: Land Resource Inventory and Land Management Information System

The Minnesota system is also involved in the visualization of land and resource data. The basic unit of study is the 40-acre parcel into which the following information is encoded:

1. Location--county, township, and range; section and 40-acre parcel locations; government lot number; latitude and longitude; minor civil division (township, village, city, etc.)

2. Contiguity to lakes or watercourses--whether bordering or bordered by or containing lakes, rivers, and streams

3. Land Use--use to which the land is devoted, based on the following classifications:

| | |
|---|---|
| forested | urban residential |
| cultivated | non-residential or mixed-residential |
| water | open pasture |
| marsh | extractive |
| transportation | |

4. Ownership--private or public and, if public, the managing agency

The overall objectives of the system are being dealt with in three ways:

1. The study group is undertaking interdisciplinary research projects within the University of Minnesota and joint University-State agency research projects

2. Encouraging public officials to use new techniques; such as computer mapping. Four State agencies are currently utilizing these computer techniques. This is fostered by having the project researchers work part time with these agencies

3. Encouraging the cooperation of State agencies in keeping resource data current and in adding new data to the existing computerized collection

The study was initiated and coordinated by the Environmental Planning section staff of the State Planning Agency and the Department of Natural Resources.

The first step was the combining of a broad range of data that had been separately collected and maintained by different State agencies into a compatible computer system. Like New York, Minnesota's project required aerial photos to be taken of the entire State. The 40-acre parcel was determined as best since this is the lowest common denominator of the public records.

The MINMAP program was designed to print out, spatially, township blocks by 40-acre tracts. Somewhat like New York, they use overlapping or over-printing techniques to produce shaded printouts depicting the various use, resource, and other characteristics of the land for each 40-acre map. The land use maps cost about $270,000. Total costs came to roughly $3

per square mile (compared to $10/square mile in New York). Again, costs were split between the State and federal governments.

WISCONSIN: Planning Information System

The Wisconsin Planning Information System is defined as an organized assemblage of knowledge designed to service the planning and decision-making needs of Wisconsin State government. They developed a three-phase approach to the system. The initial phase was to produce an interim system which was an inventory and catalog of data and information existing within or available to Wisconsin State government and considered useful to planners. The requirements they cited for this subsystem were:

1. A subsystem which provides State government planners with an index of currently available planning data and information and the associated sources

2. A subsystem which could be developed and implemented in a minimum period of time to bridge the existing information knowledge gap

3. A subsystem that could be developed concurrent with the development of the succeeding subsystem phase and which provides a basis for subsequent phases

4. A subsystem that could be used efficiently by planners and result in more effective utilization of existing data and information

Design analysis revealed the need for three basis subsystem components:

1. A well-defined and ordered hierarchical structure to classify all planning data and information

2. A state-wide inventory of data and information existing within State government or available to State government

3. A set of catalogs and/or directories of State data and information covered by the inventory and framed within the classification structure to facilitate planning use

The classification structure was designed to facilitate retrieval of information easily and, to this end, was kept as consistent as possible with existing statutory classification structures. First, it provides an outline of subject catagories into which data gathered in the State data inventory

were conveniently arranged. Second, when the State data inventory and the classifications were merged, data gaps and repetitions became evident. Third, the classifications scheme provided the design for the organization of a series of topic catalogs that housed information on the content, reliability, and location of data retained by or available to State government.

A hierarchical arrangement of topics, ranging in detail from general to specific, was considered the most meaningful and practical organization for the coding and retrieval of information. Considering the needs of planners, the data was collected and stored on a subject basis. Each agency conducted its own physical inventory using its own personnel under the guidance and with the support of the Bureau of State Planning. The various State agencies provided descriptions of approximately 2,400 of their record series (files) along with copies of the associated records (forms, reports, etc.). From these materials personnel assigned to the Data Inventory Center identified, classified and coded approximately 175,000 individual data elements. The data elements and file descriptions were translated into data processable format, processed via computer, and published in a set of directories.

The primary requirement for the "Intermediate Subsystem" was the need of a mechanism which produces statistics and utilizes statistical techniques in support of State government planning and decision-making--a mechanism which bridges a substantial part of the gap between the Interim and Comprehensive phases of the system development sequence. Such a statistical system is by nature a product-oriented system, consisting of past, present, and future aggregated data, retrievable by either manual or automatic means.

The first edition of the Wisconsin Statistical Abstract, published in 1969, was intended as a general reference book containing population projections, resource projections, socio-economic projections, socio-economic

indicator series and planning indicators, the latter of which assist planners in projecting changing situations and the effect of program responses over a period of time.

The expanding capabilities of the system soon justified the adoption of automated means of retrieving, manipulating, processing, and reporting data, information, and statistics. Additional requirements and design analysis resulted in the development of the Statistical Information Processing Subsystem (SIPS). The concept behind SIPS is that the user be able to inquire via a terminal device or punched cards to retrieve statistical data or groups of data and to have this data outputted as is or processed in a statistical fashion with output directly on the terminal or through a report process. SIPS consists of seven different program areas:

1. Report-generator-edits--consisting mainly of the data preparation and edits required to produce a report
2. File Maintenance--updating of files
3. Data File--contains data used in outputs, extracted by data element, geographical unit, and/or time unit
4. Catalogs--index of all data elements in the system and their attributes
5. Scientific Computational Routines--(SCR) consists of necessary computer routines, techniques, and tools to accomplish the statistical processing of data in the system
6. Inquiry Capability--inquiry into the SIPS file and extract data directly or process it and then output it, also available through punched card
7. Computer Graphics--included within SIPS to enable user to retrieve data in graphic form

The final phase of the Wisconsin system, termed the "Comprehensive Subsystem," is an ongoing continuous effort to update the efficiency of the component programs and evolve greater utility in the exercise of the system's capabilities. This involves uses of Census data, interface with other infor-

mation systems; such as, the Department of Administration; Department of Health and Social Services; Department of Industry, Labor and Human Relations; Department of Justice; and the Department of Transportation; as well as widespread planning agency support.

The organization primarily responsible for the development of the Wisconsin Planning Information System was the Information Systems Section within the Bureau of State Planning. This staff consists of five full-time professionals, one full-time computer programmer, one full-time data researcher/analyst, and one full-time secretary. Additional staff was supplied on request by the Department of Administration. The professional talents represented in the staff are systems engineering, political science, economics, mathematics, geography, sociology, demography, administration, statistics, psychology, and linguistics. Cost funding sources were not available, but it is assumed that the federal and State governments shared the expenses.

FLORIDA: Master Data Processing Plan for Resource Management

The Environmental Data Processing Management Board (EDP) was created in 1967 through legislation passed by the State House of Representatives. The Board was authorized to:

1. Establish and supervise the administration of data processing centers deemed necessary to best serve the data processing needs of all agencies
2. Arrange for and effect the centralization, consolidation, and community use of equipment and services deemed necessary to obtain maximum utilization and efficiency in data processing operation
3. Transfer to any data processing center the data processing activities of any agency
4. Arrange for the transfer of data processing systems and operating personnel employed by the various agencies

The State Reorganization Act of 1969 consolidated 160 agencies into 23 departments. This program was designed more as a management system than

an environmental system. However, they faced a number of problems; such as differing cataloging systems among agencies, coordinating agencies with widely disparate functions, and anticipating all possible user needs and desires. In addition, dealing with all the data processing functions in State government, there was less opportunity to individualize programs and systems to serve the needs of all the agencies particular activities, such as was done with the planning operations in Wisconsin. They spent considerable time and effort designing for the accessibility of the potential user. To this end, they set up operations in several State colleges and universities throughout the State.

TEXAS: Natural Resources Information System (NRIS)

The Natural Resources Information System can be portrayed as a hierarchical network in which each center can be seen from a functional and an organizational viewpoint. A user enters the system at one of the many entry points or data centers. At these access centers the request for information is analyzed, formalized, and processed. The system may respond by disseminating to the user a list of information sources for the user to contact, a list of documents for the user, a set of documents for the user to read, physical samples or raw data for the user to analyze, a set of displays showing the user the results of the system analyzing the data on the users behalf, a list of algorithms (or the computer programs themselves) to do some analysis of raw data or combinations of these. The products, usually given out at the entry point, can be documents, physical samples, imagery data, or raw data. Moreover, provisions for mail or communications of output to the user by mail, etc., can be made.

Each center would be specialized in scope, with the degree of specialiaztion increasing as one goes down the hierarchy. Thus, the store of data

in the center decreases with the hierarchy. Management is an important segment of the hierarchy. The specific palm of organization would determine the degree of autonomy each center has over its own affairs.

An operational Single Agency Natural Resources Information System would consist of three major subsystems: (1) a data handling subsystem, (2) a data acquisition center, and (3) an administration subsystem--all housed in a single center.

The data handling subsystem would perform three main functions: (1) data collection, (2) data processing and storage, and (3) data distribution. The single agency NRIS would perform the following functions:

1. Initially processing all data received, including recording, annotating, cataloging, and indexing
2. Reproducing data for storage, analysis, and further processing
3. Further processing, including image enhancement, rectification, digitizing and gridding
4. Maintaining and administering a Working Data Bank, that is, a point at which those data with high utilization potential are deposited
5. Maintaining and administering a Permanent Data Bank, that is, a depository for all data received into the system
6. Providing any special processing requested by users
7. Coordinating the components of the system

This selective survey of the literature on existing information systems implies a set of technical benefits and costs which should be made explicit for the decision-maker.

Technical benefits of computerized information systems may be stated as follows:

a. Lower operating costs of data processing
b. Faster availability of information
c. Generation of new information never before observed, recorded or reported
d. Consistency in reporting data
e. Reduction of data distortion
f. More freedom from routine record-keeping

There are some technical costs which should be pointed out:

a. Increased capital costs, including both hardware and software
b. Demands for highly skilled personnel
c. A tendency toward greater reliance upon quantifiable and measureable variables
d. Since computers are programmed to respond in a certain fashion to new types of data or two nuances in the information that may signal changes within the environment
e. Reduced sensitivity to opinions and self-interest of officials is not built into automatic systems

Three critical deficiencies of existing information systems also have become visible. These may be listed as follows:

1. Many systems have been limited to one political-geographical area which does not always represent the complexity of some of the problems to be solved. That is, problems are regional in nature while the system is limited to one area

2. It has been assumed that once a computer was installed that the machines would and could support both an internal management information system and the long-range information processing needs of planners. However, there are significant variations between information generated for daily governmental operations and short-range analysis of large regional environments which planners must contemplate

3. The validity of data, it must be remembered, changes over time. Furthermore, it is necessary to develop an information system which can model complex problems with rigor and meaningful assumptions

Lundberg (1967) makes mention of some further conceptual concerns by the following statement:

> "Urban areas have been liberally discussed as systems and sets of subsystems, but perhaps they should also be viewed as environments within which the systems function. To speak of an environment does not refer narrowly to a state of nature but here more usefully to the selectively identified social, physical, and economic components of an urban complex. Within this broad taxonomy, there could be detailed such categories as urban demography, social activities and problems, physical artifacts, cultural activities, and both abstract and material economic items, with special emphasis upon geographic locations, kinds and rates of change, and various correlations of significance to public and private decision-makers. When the urban area is thus viewed with some meaningful sense of wholeness, the way is open to consider an adequately whole information system and data bank that can represent the metropolitan complex in a powerful way."

With the conclusion of this brief review of some of the major conceptual and technical problems as well as the existing information systems the next section recommends a potential structure for the State of Nebraska.

# IV. A POTENTIAL DESIGN FOR THE REGIONAL-ECOLOGICAL INFORMATION SYSTEM

In this section some definitions are offered; the general objectives and specific objectives of the three phases of development of the system are offered; and finally, the design guidelines for the system are discussed.

## A. Some Basic Definitions

An information system may be considered as consisting of elements (personnel, computer software and hardware) performing activities (acquisition, storage, retrieval, and analysis of data) in a manner defined by methodologies, procedures, and organizations to obtain information.

The differences between "information" and "data" are important for both the design of a system and the incorporation of the system. Kennedy and Woodside (1969) contrast the meanings in the following statements:

> "Data--are numbers or unit facts frequently repeated, whereas information is ideas.
>
> "A datum is a fact in isolation. Information is an aggregate of facts so organized or a datum so utilized as to be knowledge or intelligence. Information is meaningful data, whereas data, as such, have no intrinsic meaning or significance.
>
> "Information is the concept relating data which otherwise is meaningless to some specific human purpose or objective."

Whereas data include such items as population figures, tax receipts, welfare recipients, and so on, information is considered to be the relationships between different data to yield some partial solution to a particular problem under study.

Conversion of data into information requires more than the manipulation of data within a memory device and more than its reproduction in various formats. The conversion process begins with effective and efficient storage and retrieval of data followed by analysis of the data so that more information is derived (Kennedy & Woodside, 1969, p. 14).

B. Some Basic Assumptions

A system is conceptually developed which calls for an integrated ecological information and decisional systems approach. This approach makes certain basic assumptions about the nature of the natural and man-made environments. The more salient of these assumptions are as follows:

1. The environment is conceived of as an integrated (eco-system) information system, composed of major subsystems. In such a manner, the major informational flows can be identified as to data input sources, the processing, and the items of data which are common to more than one functional area

2. The innate capacity of the computer can be most effectively utilized by an agency if all of its data processing needs are first considered as parts of a total system and then a series of computer programs designed which permit a maximum reliance on the computer for routine processing of data required for departmental operations

3. Most of the data required should be significant not only for management decisions, but for assisting in the development of long-range plans, and strategic plans

4. If all operational input data is computerized upon its generation, and if due attention is given to its accumulation and storage, the resulting data aggregation will approximate the data bank concept and will be an incidental and inexpensive by-product of the total operating system

5. The system to be designed must be open-ended to accommodate inputs from many governmental jurisdictions and levels

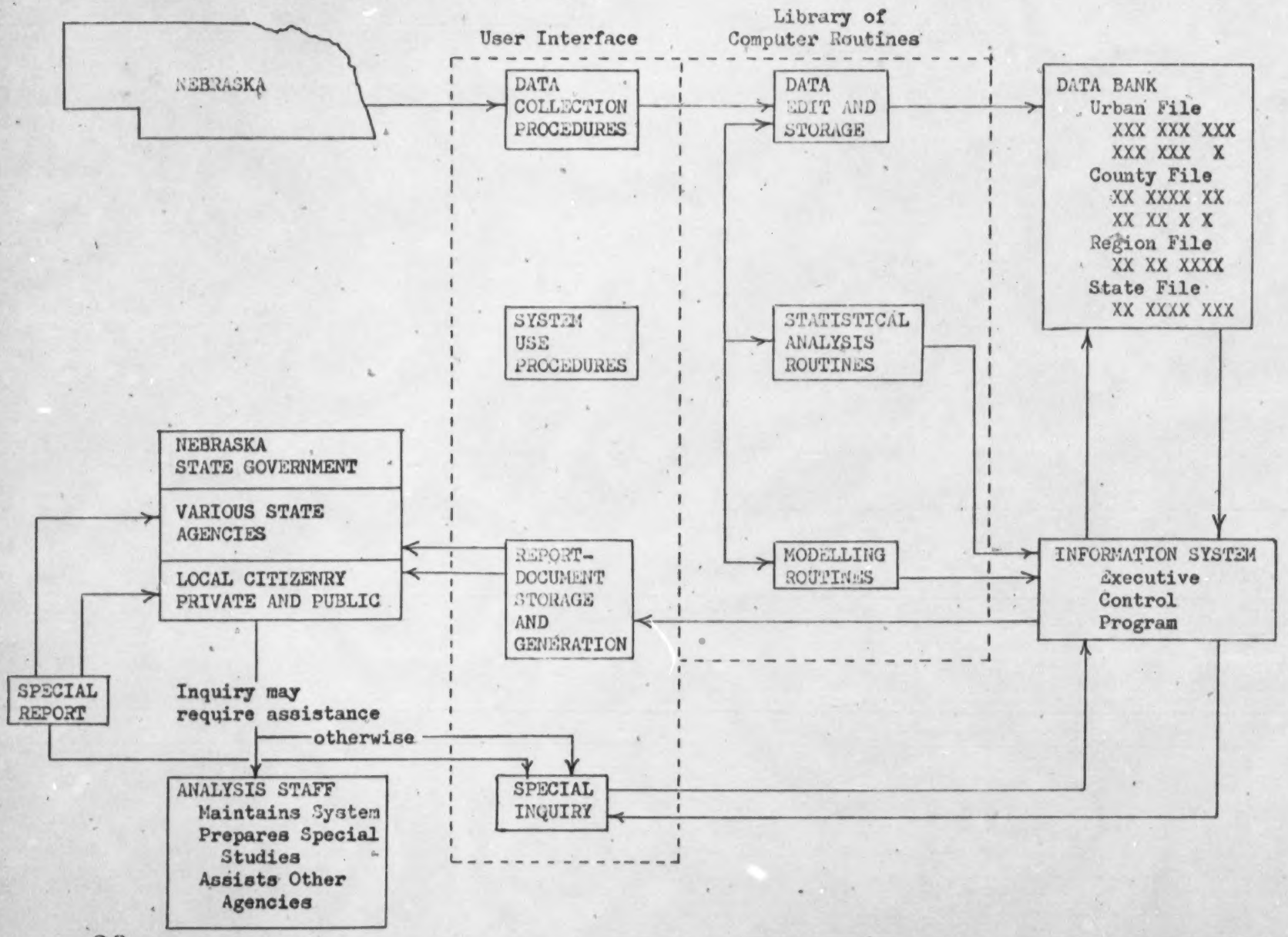
6. The system must be incrementally expandable

Related to the problem-solving process and regional planning, it is important to be aware of one implication presented by an information system. Information for any decision process is generally compiled in terms of the decision and the few individuals or agencies directly responsible. The information required to arrive at a solution to each set of problems is different and cannot at all times be anticipated.

The Regional-Ecological Information System consists of two major components. One is an analysis staff of individuals with:

1. A knowledge of available data and information about the state and its resources, operations, and government

THE GENERALIZED NEBRASKA ENVIRONMENTAL PLANNING INFORMATION SYSTEM



2. An ability to perform systems analyses similar to those required by a Programming-Planning-Budgeting System

3. An ability to understand, interpret, and formulate models of various state operations

4. An in-depth understanding of the computerized component

The second component is the computerized operation which provides:

1. Certain data which partially describes the general planning environment

2. Models to be used in either forecasting or in answering "what if--" questions (i.e., what happens to levels of social interaction if population density within a certain area increases

3. Certain statistical procedures to be employed to analyze data that is already in storage or inserted for a particular problem

C. General Objectives of the System

The general objectives for a regional-ecological planning information system are as follows:

1. The system should provide the information required for strategic regional planning and community development in an effective and efficient manner. All elements of government performing regional and local planning should have ready access to this information. (Such elements include the various State agencies, the Governor, and the Legislature.)

2. The system should incorporate sufficient flexibility and generality to remain viable in the increasingly demanding planning environment of the future

3. The system should provide a consistent and thorough information base for all planning operations. The system should provide information for the determination of the premises used in these planning operations (e.g., population projections generated within the system should form the planning premises for the many agencies who base their activities on anticipated population; using one set of projections insures consistent planning by these agencies.)

4. The system must be fully cognizant of individual rights of privacy and must incorporate safeguards against invasion of this privacy

5. The system should be capable of accepting data from sources external to varying levels of government

6. The system must be user oriented. In all trade-offs between system capability and required planner performance, the system should be designed so as to provide maximum assistance to the planner

7. The system should be economically justifiable. This objective follows from the first objective; if the system is not economically justifiable, it is by definition inefficient

8. System design and implementation should follow an evolutionary pattern with each phase of the evolution so designed that maximum capability at minimum cost is realized

Proposed Development Strategy

It is recommended that an evolutionary design strategy be followed. Such a strategy achieves a system design in successive steps or phases. An alternative to an evolutionary design approach is that of the single phase design or "one-shot" approach. The conditions which warrant an evolutionary design are:

1. The system requirements cannot be clearly defined and there is some uncertainty involved

2. The system and its environment are subject to change

3. The system design will require time for both actual development and for experience in using the various system components

D. Specific Objectives for the Development Phases of the System

In this section is an outline of the specific objectives for the first three phases of the design process--an initial demonstration system, an initial operational system, and the first modification to the operational system.

Specific Objectives - Initial Demonstration Phase

The specific objectives for this phase are:

1. The design shall provide an operating demonstration system that would yield (a) experience with the available personnel and equipment in the state's Data Processing area, and (b) experience with meeting demands for planning information

2. An evaluation of this system's operation should be performed. Data required for this evaluation include (a) user acceptance, (b) interaction between the user and system, and (c) requirements for future system capabilities, e.g., computer memory size, forms required for requesting information, and anticipated computer usage

3. The system should provide a bibliographic or documentation unit for report classification and storage of important references, as well as abstracts

4. The system should provide a basic data edit and storage capability

5. The system should provide a basic statistical analysis capability

6. The system should incorporate certain models useful in the abstraction of information. These might include (a) a population model for estimating certain demographic characteristics by county (e.g., sex, age and race) and projecting population characteristics to future years; (b) a series of economic indicators for the state; and (c) a recreation needs analysis, and so on

7. The system should establish a data bank containing the required data for the above functions

8. The computer capability and personnel of Data Processing should be used as a design standard; i.e., the system should be realizable without additional computer capability and with minimum additional procedures for facility operation

Specific Objectives - Initial Operational Phase

The second configuration of system design is recommended to include data processing routines to provide certain planning information required at the higher levels of government. The emphasis during this phase of development is upon providing a general information background required by the Legislature and Governor and the State Office of Planning and Programming in making broad policy decisions. Specific agency-oriented information requirements are reserved for subsequent system modifications. The information to be provided during this phase may be useful to various agencies in their planning (e.g., estimates of car registrations based on population estimates); however, the intent is primarily that of providing top level government, such as the State, with a general indication of the state's status, progress and the future environment.

The specific objectives for this phase are:

1. The system should provide a minimum set of information necessary for regional ecological planning

2. The system should provide the information necessary to measure performance in a minimum number of significant areas within the state's, region's and the community's operations. For instance, potential candidates would include such data as health statistics, income statistics, indications of anti-social behavior, education, natural resources, and so on

3. Evaluation of system usefulness in the regional ecological planning process should be determined. This evaluation will require the identification of suitable performance measures and the inclusion in the system design of a means of collecting the necessary performance data. One outcome of this evaluation would be the identification of potential modifications

4. The system should provide a capability of generating special reports defined by the requester and based upon data stored in the data bank. This report generation would only require a minimum knowledge of system's operation by the report requester; i.e., the requester need only define what he wants and the format in which it is to be presented

Specific Ojectives - First System Modification

The third phase of systems evolution will include data processing routines to provide information pertinent to specific agency planning. No attempt will be made to provide an agency with all the information required, nor to provide all agencies with their needs. A judicious selection of strategic needs for certain agencies, based upon considerations both of the feasibility and of the gains to be realized from implementation, will be used to determine what information for which agency will be attempted during this phase. Later modifications compatible with a centralized information system will supply larger segments of these agency planning information requirements.

The specific objectives for this phase are:

1. The system should incorporate economic models that would indicate the impact upon the various sectors of the state's economy resulting from changes in both policy and external variables. Typical examples are the effects of tax increases upon revenues, and increasing population effects on government personnel requirements

2. The system should provide certain information necessary for evaluation of certain program areas within the state. The exact information will be defined during system design and will be determined by the performance measures included in the previous phase and the relative priorities of the various programs

3. The system should provide the information requirements for certain specific agency planning activities. For example, the basic information required for comprehensive recreation planning is one area which could be considered within this phase of system design

4. The system should provide a graphical display capability both for display of data on geographic basis (data displayed by state or county) and data displayed in a tabular or curve format

5. The system should provide an advanced edit and storage capability

6. The system should provide an advanced statistics analysis capability

E. The Design Process for the Regional-Ecological Information System

The design process described is preliminary for it is thought to be the major task of the design staff. Therefore, only the initial framework should be provided prior to their acquisition and participation. The emphasis then is to acquire such a staff; for until this is accomplished, the design and implementation of the system cannot begin. It is suggested that such a staff could consist of persons from respective state agencies and the University of Nebraska-Lincoln where experienced personnel already are employed.

Initial Operation Phase

The system design may be defined in terms of personnel, data, programming, equipment, and displays.

The elements described below provide a preliminary design. The design requirements should be derived later by the information system staff. Tasks to be performed by this staff include:

1. System Design--the transformation of system objectives first into requirements and then into an operational system

2. System Programming--the preparation of an overall computer program specification and coding of certain particular segments when other sources of coding are not available

3. Awareness of Information--the maintenance of a familiarity with all document and data sources within the state; the maintenance both of an index of the sources and of a library of the significant data which is not stored in the data base

4. Awareness of Information Needs Within State Government--the maintenance of liaison with the various state agencies in order to determine their data and information needs and to provide assistance where possible

5. System Operation and Maintenance--the performance of those tasks required to maintain an operating system, produce the required periodic reports, and incorporate those minor changes necessary for compatibility with equipment and software modifications

6. Model Operation and Maintenance--the performance of those tasks necessary both to maintain the models within the system "up-to-date" with current conditions and to operate the models

7. Procedures--the preparation of the procedures necessary for system operation

8. Special Information Requests--the performance of the necessary analysis and data processing to produce information not normally provided by the system.

Introduction of the System to the various state agencies by means of the provision of lectures and demonstrations to various groups. Also, the staff would be called upon to perform this presentation to local communities and interested citizens outside state government.

In order to realize these tasks, the staff should be composed of individuals possessing the following characteristics:

1. Ability (a) to perform systems level computer program design, (b) to prepare program specifications, (c) to code in FORTRAN, and other possible machine language, and (d) to perform computer program debugging

2. Ability (a) to perform system analysis, (b) to model socio-economic systems, and (c) to maintain such models by re-estimating parameters and evaluation of model results

3. Ability to prepare and deliver presentations of the information system to various groups

4. Ability to manage a large scale information and analysis project. Such a staff would be comprised initially of a manager, a systems analyst, a programmer, and a clerk. The staff would be augmented in time by the addition of mathematical aides, programmers, analysts and a secretary

Urban and regional planning is normally performed by personnel with the State Office of Planning and Programming. The information system should provide the planning analysts with their required data analysis and modeling necessary to properly fulfill the planning function.

Some recommended tasks to be accomplished during this phase are the different document storage units and the specific model components. Emphasis is placed on the Recreation-Tourism Subsystem. Other tasks to be developed are:

a. A Performance Measures Component--data must be collected and processed to provide measures of performance for selected programs. This design will require the description of those programs which are to be evaluated, definition of appropriate measures, design of a data collection procedure, programming of the routines for data processing, and generation of output reports. Information from this program will be useful in the analysis required in a Programming-Planning-Budgeting system

b. A Special Reports Generation Capability--a capability to process special reports, based upon data contained in the data bank at the request of a user. This capability will allow a user to request the presentation and limited processing of any data contained in the data bank. The requested information will be presented in a special format defined by the user

The appropriate data collection programs, procedures for the maintenance of data collections, updating and processing of data must be defined. The data bank structure should also include the ability to process data by county, urban area or community, region, and state.

System design should be reviewed and evaluated by the intended users as it is being developed. An effective way of insuring such a review is the scheduling of periodic design reviews where the design to date would be presented to the interested users and their comments, questions, and criticisms solicited. All questions as to the adequacy of the design should be formally answered. Those revisions to the system which arise during these reviews would become the basis for future design efforts.

Design - First Modification to the Operational System

Certain modifications to system structure will become evident during the design and implementation of the initial operational system. In addition, this system should expand to provide increasing information services to various state agencies. The first modification to the system is designed to incorporate those changes uncovered during system use and to include those capabilities required for agency services.

The acquisition of the information staff begun during the initial phase of system design will continue with the acquisition of additional programming and analysis capabilities. By the end of this design period, the staff should have reached a stable level for at least several years of operation.

The basic design tasks to be undertaken during this phase include:

1. Incorporation of Impact Capability--provisions should be incorporated to allow the use of one model's output as input for a second model--thereby determining the inter-model effects. For example, increases of population within the population model would have an effect upon the government services required in the services model. These inter-model effects, when augmented with other models (e.g., the effects of industrial growth on urban populations) would provide a means of answering various "what if . . ." questions

2. Program Evaluation Capability--data on various measures of program performance will have been collected during the previous phase. This data can be processed to provide performance information which, when augmented with program costs, would provide a basis for a program evaluation report. This capability should be included during this phase

3. Community Recreation-Tourism Planning Information--a typical area amenable to a community planning treatment should be selected and the required information derived. The recommended area is that of Recreation-Tourism planning. The collection and processing of the required data and provision of the necessary information for program planning in this area would provide an effective test of the information system capability. Various Recreation-Tourism Planning data currently exist; the processing of these data into useful planning information would assist in the difficult task of community recreation planning

4. Graphic Display Capability--the incorporation of this display capability is a further extension of the user's interface component--similar to the special reports package. Such a capability would allow the display of data on a geographic basis (e.g., maps of income by county, crime rate by city block). This graphic presentation affords a rapid and effective means of analysis. This capability would be based on the SYMAP program currently used by the Departments of Geography and Planning, University of Nebraska-Lincoln

5. Advanced Edit and Storage Capability--the edit and storage program envisioned for use in the first phase of the system should be available within Data Processing. An edit and storage program that incorporates a maximum capability for data preview, edit and storage should be developed. Incorporation of this program in the system will prevent the insertion of erroneous data. This attribute will become increasingly important as the data bank becomes larger

6. Advanced Statistics Capability--the initial statistical analysis package should provide the required analysis capability for the earlier stages of system operation. However, additional capability will be required with the increased demands for analysis

The data bank will be increased to contain the necessary data for items 1-3. In addition, a data bank manipulation routine should be designed to allow data summary by region and SMSA.

Programming tasks for this phase of system design are to:

1. Translate the definitions of the impact models into program specifications, define input data requirements, define the output formats, code the program, and integrate into the information system--this latter task includes all computer trials, trouble-shooting and procedural shakedowns required

2. Perform functions similar to item 1 for the program evaluation capability

3. Perform functions similar to item 1 for the community Recreation-Tourism Planning information module

4. Integrate the SYMAP program into the information system, which requires the inclusion of SYMAP control in the system executive routines

5. Integrate the advance edit and store program

6. Integrate the advance statistics capability. This will require the integration of available programs into the system

7. Modify the system executive as required

## V. INDOOR-OUTDOOR RECREATION-TOURISM SUBSYSTEM

Since the end of World War II, the American Society has slowly been lifting the constraints imposed by a work ethic and Puritan tradition resulting in an increased rate of growth in recreation participation. The concomitant increases in population and mobility, affluence, and leisure time promise growing demands for indoor-outdoor recreation, and thus a greater need for recreational space and supporting facilities.

Within the State of Nebraska there is reason to believe that trends are occurring similar to the national picture. The State Comprehensive Outdoor Recreation Plan (S.C.O.R.P.) outlines the economic factors which tend to effect the growth of leisure participation. Results of the 1972 survey published in the S.C.O.R.P. demonstrate the types of activities in which the residents occupy their recreational time.

Recreation planning, or any type of planning, is partially concerned with the systematic collection, analysis, organization, and processing of technical information to facilitate decision-making. Given this assumption, it is important to provide high-quality information to decision-makers. This is significant because information enhances the rationality of decision-making.

Many decisions in indoor-outdoor recreation and tourism concern the supply of recreation facilities, activities, and environments. In this regard, inventory is a basic part of virtually all considerations in supply. The problem of what to inventory is usually solved by reference to standard recreation activities and from which reference is made to specific kinds of facilities. Thus, the chosen set of activities becomes the key to the identification of the resources.

Information handling is another concern in inventory and analysis. For example, the Forest Service's Recreation Information Management (R.I.M.) System is a computerized service which keeps track of use estimates, investments in facilities, and site characteristics for all recreation sites in the United States. Also included is information on the size of area, ownership, designated purpose and the type and condition of facilities, as well as improvements.

Related to the tabular presentation of statistics on recreation facilities and activities is the need for map-oriented data, storage, and presentation of the location of recreational spaces and facilities. Such information is important in terms of predicting the demand for certain facilities.

Comprehensive inventories can serve as a continuing basis for supply decisions even though recreation activities and tastes change somewhat with time.

A. Information Requirements

In this section, we outline some of the types of data that would be required to initially be stored within this component. In order to be relatively systematic and in sequence with the overall information system, we suggest three major subcomponents within the Recreation-Tourism Component. These are first, real property data; second, activity and financial data; and third, personnel or staff working in the field of recreation and tourism. Consistency in data and collection techniques will make it easier for relating to the other components of the ecological system.

Real Property Data

This information includes all data that describes the characteristics of the land and what is on it. These characteristics are particularly significant to state and local governments since the demand for many government services is generated by the condition of activities on real property.

We shall identify typical items of information that describe characteristics of real property. The group of data describing a particular piece of land form what is called the "record" for that parcel. A parcel record contains information describing (a) the location of the land, both geographically and in relation to political jurisdictions affecting it; (b) the land itself and the structures upon, under, and adjacent to it; and (c) the owners and occupants of the parcel.

Parcel Record

I. Locational Information

- A. Parcel number
- B. Parcel address(es)
- C. Legal description
- D. Grid Coordinates
- E. Street Section Reference
  - 1. Side of street on which parcel lies
- F. Parcel numbers of adjacent parcels
- G. Political and administrative jurisdictions
  - 1. County
  - 2. City
  - 3. Township
  - 4. Special district(s)
  - 5. Postal zone
  - 6. Assessment district
  - 7. Unincorporated areas
  - 8. Census tract
  - 9. Census block

II. Land and Structural Characteristics

- A. Parcel size
- B. Assessed value
- C. Taxable value
- D. Deed restrictions
- E. Easements
- F. Building characteristics
  - 1. Number of buildings
  - 2. Floor area
  - 3. Frontage and depth of building(s)
  - 4. Height of building
  - 5. Number of stories
  - 6. Number of rooms
  - 7. Year buildings constructed
  - 8. Condition of buildings

III. Owner-Occupant Characteristics

A. Owner's name and mailing address
B. Rent
C. Number of employees
D. Off-street parking spaces provided

B. Data Item Definitions

Location Information

Parcel number is an efficient way to identify each parcel of land separately in a system. A parcel is defined as "a contiguous area of land in one ownership and one general use." Developed originally for use by assessors, parcel-numbering systems customarily index every parcel of land to a basic map. The numbers themselves often refer to a map book, page, and specific parcel on that page. As defined by assessors, parcels are usually, but not always, equivalent to each piece of property with a separate basic legal description. Parcels of publicly owned property should be included in the system although they are usually nontaxable.

Parcel address(es) provides a second, though less comprehensive and accurate, index to real property parcels. Street addresses are useful in urban areas; but in agricultural, rural, and undeveloped areas, the parcel number is the only simple means of identifying property. Where several addresses apply to the same parcel, each separate address can be indexed to the appropriate parcel number.

Legal description is a narrative or numerical description of the parcel identified by the parcel number. A legal description can be in the form of "township and section," relating a piece of land to official U.S. government surveys; it can be by "metes and bounds," measured from established reference points on official maps; or it can be by "lot, block, and tract," which references parcels to maps of recorded subdivisions of property. Complete legal

descriptions, particularly those using metes and bounds, are often long and complicated and are seldom used except in connection with property titles. The abbreviated legal description identifying each parcel is a means of identifying the basic complete legal descriptions. Such a basic legal description describes every piece of land as its dimensions have been recorded regardless of present ownership or use.

Grid coordinates permits locations to be identified apart from political or topographic references. For every parcel of land there can be recorded the coordinates defining the parcel itself or the quadrangle into which it falls, according to any grid system that has been applied to the area where the parcel is located. Notations could be entered both for detailed grids where they exist and for gross coordinates in areas that have not been precisely surveyed. For many purposes, street sections can be used as grid coordinates. A grid coordinate system can be used primarily to aggregate parcels by area apart from political or jurisdictional codes.

Street section reference lists the number of any streets or alleys adjacent to the parcel. The side of the street section on which the parcel lies could be appended to the reference number.

Parcel numbers of adjacent parcels are self-explanatory.

Political and administrative jurisdictions provides a means of relating the parcel to the jurisdictions that affect it. All parcels, for example, are typically in a county and at least one school district. Larger agencies; such as police, public works, and motor vehicle departments; often have geographic subdivisions for administrative purposes. The codes for the jurisdictions can be used both to identify the jurisdictions into which a particular parcel falls and to aggregate parcels by jurisdiction.

Land and Structural Characteristics

Parcel size gives the dimensions and area of the parcel. Since urban lots are generally rectangular, front width and average depth can be recorded in feet. Area can either be calculated by a computer from length-width data or the total area itself can be recorded. For large parcels or those of irregular size, the acreage can be indicated.

Assessed value is the current assessed value of the land, improvements, trees, vines, and personal property, each separately shown.

Taxable value is the value of the parcel on which taxes are computed.

Deed restrictions include the type and effective date of restrictions.

Easements records the type, holder, and location of easements on the parcel.

Building characteristics. Into this subcategory fall all the data that describe the structures on a parcel.

Owner-Occupant Characteristics

Owner's name and mailing address can include any special ownership conditions, such as probate or trusteeship status, as well as direct ownership.

Number of employees is shown for each occupying business, separately listed if several businesses occupy the parcel.

Off-street parking spaces provided by the business.

C. Activity and Financial Data

The data to be collected in this area is relatively self-explanatory. Information should be available describing the types of recreational users and activities, as well as the programs, the costs involved and budgeting requirements.

D. Personnel Data

This section contains information about the persons involved in directing and supervising recreation programs. Also included is data on the following five components: Consultants, Government Personnel, Professors, and Students. and Community.

Consultants

1. Present recreation research studies being carried on by the firm as a whole, including the name of the agency for whom the work is being done (a brief statement of each topic and the methodology employed is sufficient).

2. Recent recreation research projects of the firm as a whole, and the sponsoring agencies (again only a brief statement).

3. Current recreation research projects of individuals within the firm and the name of the sponsoring agency. Please specify the names and addresses of the individual researchers or consultants and give a brief description of their research.

4. Recent recreation research projects carried out by these individuals, and the names of the sponsoring agencies.

5. Recreation research interests (both general and specific, list in order of importance) of these individuals within your firm.

Government Personnel

1. Present recreation research studies being carried on by your division as a whole (a brief statement of the topics and the methodology employed, plus the names and addresses of the principal researchers involved).

2. Recent recreation research projects of your division as a whole (again a brief statement of the topics and the names of the principal researchers).

3. The current personal recreation research projects (a brief statement of topics and methodology).

4. Recent personal recreation research topics (a brief description).

5. Personal research interests (both general and specific) as related to outdoor recreation and open space (list in order of importance).

Community

1. Your position in the recreation programme of the community.
2. The programmes you direct or assist with.
3. The educational training one may have had in the area of recreation.
4. Number of years of experience.
5. Perceived problem areas.

Professors

1. Current recreation research studies (a brief description of topics and the names of sponsoring agencies if applicable).
2. Recent recreation research topics (a brief description of the topics and the names of sponsoring agencies if applicable).
3. Proposed recreation research topics.
4. Research interests (both general and specific) as related to outdoor recreation and open space (list in order of importance).
5. Names of courses with which you are associated.
6. Names and addresses of graduate students working under your supervision, as well as a brief statement of their research topics.

Students

1. Present recreation research, including thesis topic (a brief statement of subject matter and methodology).
2. Recent recreation research studies in which you have participated.
3. Proposed recreation research studies.
4. Research interests (both general and specific) as related to outdoor recreation and open space (list in order of importance).
5. Name of thesis adviser.

This represents only one base upon which other data could be collected and related to the other components of the ecological system. To illustrate, discussion has not made mention of some very complex economic and spatial models of predicting demand and supply of facilities; no mention has been

made of the environmental design consideration and so on. This more detailed information and data requirements would come from recreation and tourism personnel within the government and community as well as the university.

## VI. CONCLUSION AND RECOMMENDATIONS

The original intent of the proposed research was to make available environmental information of benefit to decision-makers for community development and environmental design. Implicit in this objective is the necessity of some type of Information System capable of storing and analyzing the environmental data. Given the absence of such a structure, it became the major effort of this research to develop a possible conceptualization of an information system based upon the eco-systems approach. This Regional-Ecological Information System (R.E.I.S.) would contain two subsystems. First, an environmental subsystem containing a number of functional data components and analytical procedures, as well as a second subsystem of environmental bibliographic and research documentation.

This report offers some suggestions for the development of an environmental planning information system which is capable of handling a large number of data. Essentially, it is felt that the proposed system will ensure better decisions and a better execution of the total planning process. Therefore, there exists the basic recommendation that the decision be made to undertake such a planning information system, acquiring the staff, making available the equipment and collecting the necessary documents, data, etc., required for its operation.

Personnel

The acquisition of an adequate staff is of prime importance in insuring the dynamic characteristics required of a system. The staff is its strategic factor; without it the system will be totally ineffective. Additionally, system design cannot commence until the initial members of the staff have been acquired.

Since these types of personnel are in relatively short supply, a possible short-term solution to the problem would be the use of outside capability to augment the planning staff. For instance, consulting firms or university personnel might act as a "stop-gap" measure.

Equipment

As currently envisioned, the design of the system would most likely exceed the current capability of the equipment. Additional memory capacity should be acquired before any computer programs can be designed.

System Evaluation

The impact that the planning information system will have upon decision-making within the State and Community infrastructure is directly related to the responsiveness of the system to the needs of the various decision-makers. There must be an active program to acquaint government personnel, legislators, and the general public with the capabilities of the system and assist these people in the use of the system to supply them with needed information. Also, an evaluation of system performance and incorporation of appropriate changes should be accomplished throughout system life. In addition, formal design reviews and suggestions for improvement should be solicited from all agencies. A constant effort should be made to incorporate as many recommendations as possible based on feedback of user evaluation into the system.

Every attempt should be made to optimize the utility of the system for analysis not simply as a data bank. In relating all the various sub-components of the Ecological Information System it may eventually be of greater benefit not only at the State and Regional levels but at the more micro-level of the Local Community.